The grey system theory, first proposed by Professor Julong Deng in 1982, avoids the inherent defects of conventional, statistical methods and only requires a limited amount of data to estimate the behavior of an uncertain system.

According to the study of the grey system theory, the field of the grey system can be summarized in six parts.

1. Grey generating

The idea of grey generating is the idea that disorderly raw data can be turned into a regular series for the benefit of grey modeling. The grey generating including four parts[5]:

(1) Grey relational generating operation: GRGO

The mean of GRGO is to add new information for the system needs. In other word, it based on the processed data to find the rule of data.

(2) Accumulated generating operation: AGO

The means of AGO is using the data accumulated operation to reduce the randomness of original data.

(3) Inverse accumulated generating operation: IAGO

Inverse accumulated generating operation is the anti operation of accumulated generating operation.

(4) Localization generating

The main purpose of localized generating is the sequence of non-equigap, or missing data, then we can use this method to reconstruct the lost data, and make the sequence became equal-gap.

2. Grey Relational Analysis: GRA

This model is an impacting measurement model, which takes the measurements of relations that change in two systems or between two elements into the system in time, there are two types of model construction, which are:

(1) Localization grey relational grade: [LGRG]

In the localization grey relational grade, a reference sequence is given, and we can use the formula to rank the sequence.

(2) Globalization grey relational grade: [GGRG]

In the globalization grey relational grade, each sequence can be the reference sequence, and we can use the eigenvector method to rank the sequence, can also choose the optimal sequence.

3. Grey Model: GM

This method uses dummy concepts to translate difference equations into differential equations. There are three types of model construction, which are.

(1) GM(1,1) model

GM(1,1) model means first differential and one variable, the function of this GM(1,1) model is being used in the prediction field.

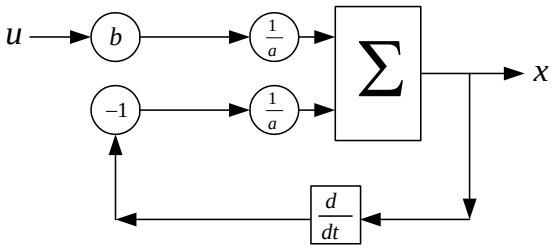

Figure 1 GM(1,1) model concept

(2) GM(1,N)model

GM(1,N) model means first differential and N variables, the function of this GM(1,N) model is being used in multi-variable analysis field.

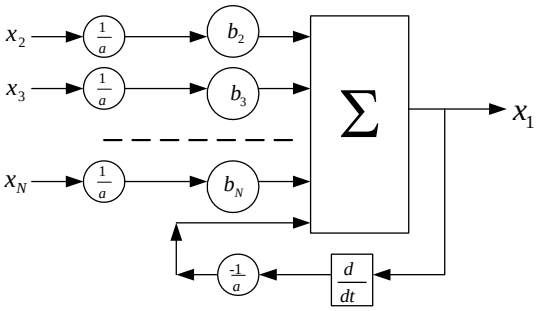

Figure 2 GM(1,N) model concept

(3) GM(0,N)model

GM(0,N) model means no differential and N variables, the analysis steps of GM(0,N) model is same as the GM(1,N) model, and also is the special type of GM(1,N) model.

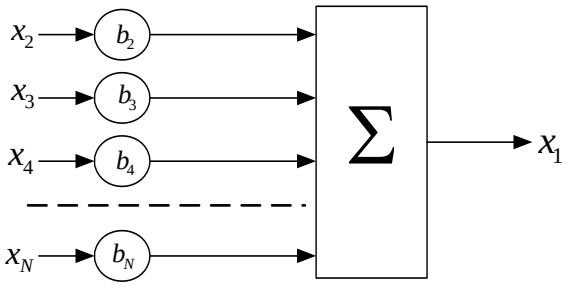

Figure 3 GM(0,N) model concept

4. Grey Prediction

Based on GM(1,1) model, we use the model to make the prediction. In Table 1, we list the prediction method, which includes the traditional method and grey method.

Table 1 The comparison between traditional prediction with the grey prediction

Mathematics model	Minimum data	Type of data	Interval
Simple exponential	5 to 10	Equal gap	Short
Holt's	10 to 15	Same trend and regular	Short and middle
Winter's	At least 5	Same trend and regular	Short and middle
Regression	At least 10 or 20	Same trend and regular	Short and middle
Causal regression	At least 10	Mixture type	Short, middle and long
Time series method	At least 2 pick value	Mixture type and regular	Short and middle
Grey Method	At least 50	Equal gap	Short, middle and long
Grey Method	Only 4	Equal gap and not equal gap	Short, middle and long

5. Grey Decision Making

Combining other methods with the GM(1,1) model to solve decision making problems, there are three types of model construction, which are.

(1) Grey rules of situation

Grey rules of situation, deals with strategy making based on multi-objects that are contradictory in the ordinary way.

(2) Grey decision-making group

This field includes grey relational space, grey statistics, grey clustering and grey prediction.

(3) Grey programming

Based on the traditional programming, to incorporate the grey prediction model in order to make dynamic programming and to regard the coefficients as grey number with provision for adapting to the environment.

6. Grey Control

Using the data to find the trend of system behavior, and then combine it with the prediction method to make the control system more optimal. In Figure 4, we show the function of GM(1,1) model in the control system.

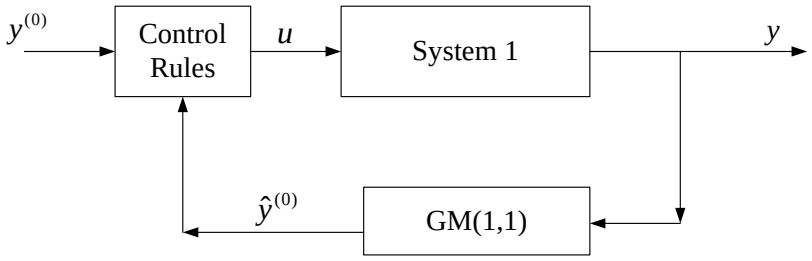

Figure 4 The block diagram of grey control

where: (1) $\hat{y}^{(0)}$: The prediction value of system behavior

(2) $y^{(0)}$: The assigned quantity

(3) y : The output of system

(4) u : Control rules

In summary, the main purpose of the grey system theory focuses on the relation between the analysis model construction, and for circumstances such as: no certainty, multi-data input, discrete data, and insufficient data through predicting and decision-making